



LONDON- WEST MIDLANDS ENVIRONMENTAL STATEMENT

Volume 5 | Technical Appendices

CFA10 | Dunsmore, Wendover and Halton

Data appendix (AG-001-010)

Agriculture, forestry and soils

November 2013

LONDON- WEST MIDLANDS ENVIRONMENTAL STATEMENT

Volume 5 | Technical Appendices

CFA10 | Dunsmore, Wendover and Halton

Data appendix (AG-001-010)

Agriculture, forestry and soils

November 2013



Department for Transport

High Speed Two (HS2) Limited has been tasked by the Department for Transport (DfT) with managing the delivery of a new national high speed rail network. It is a non-departmental public body wholly owned by the DfT.

A report prepared for High Speed Two (HS2) Limited.

High Speed Two (HS2) Limited,
Eland House,
Bressenden Place,
London SW1E 5DU

Details of how to obtain further copies are available from HS2 Ltd.

Telephone: 020 7944 4908

General email enquiries: HS2enquiries@hs2.org.uk

Website: www.hs2.org.uk

High Speed Two (HS2) Limited has actively considered the needs of blind and partially sighted people in accessing this document. The text will be made available in full on the HS2 website. The text may be freely downloaded and translated by individuals or organisations for conversion into other accessible formats. If you have other needs in this regard please contact High Speed Two (HS2) Limited.



Printed in Great Britain on paper
containing at least 75% recycled fibre.

Contents

Contents	i
1 Introduction	1
2 Soils and Agricultural Land Classification surveys	2
2.1 Background	2
2.2 Soils and land resources	3
2.3 Soil and land use interactions	8
3 Forestry	16
4 Assessment of effects on holdings	17
5 References	22

List of figures

Figure 1: Upton 1 (342a), Wantage 1 (342c), Andover 1 (343h) and Block (512e) associations in a landscape context	6
Figure 2: Methodology for calculating Agricultural Land Classification grade according to soil droughtiness	10
Figure 3: Agricultural land classification grade according to soil wetness	14

List of tables

Table 1: Bedrock and soil forming materials	4
Table 2: Dominant soil series	6
Table 3: Agro-climatic conditions at Grove Farm	11
Table 4: Soil profile description from Grove Farm	11
Table 5: Interpolated agro-climatic data	12
Table 6: Area of woodland within the study area and construction boundary	16
Table 7: Summary of assessment of effect on holdings	17

1 Introduction

1.1.1 The agriculture, forestry and soils appendix for the Dunsmore, Wendover and Halton community forum area (CFA10) comprises:

- soils and Agricultural Land Classification (ALC) surveys (Section 2);
- forestry (Section 3); and
- farm impact assessment summaries (Section 4).

1.1.2 Maps referred to throughout the agriculture, forestry and soils appendix are contained in the Volume 5, Agriculture, Forestry and Soils Map Book.

2 Soils and Agricultural Land Classification surveys

2.1 Background

2.1.1 The soils and agricultural baseline conditions reported have been established from desktop studies and site surveys.

2.1.2 Information gathered by desktop studies has related primarily to the identification of soil resources in the study area, the associated physical characteristics of geology, topography and climate which underpin the assessment of agricultural land quality, and the disposition of land uses. The main sources of information have included:

- National Soil Map¹;
- Soils and Their Use in South East England²;
- solid and superficial deposits from the Geology of Britain viewer³;
- gridpoint meteorological data for Agricultural Land Classification of England and Wales⁴;
- Provisional Agricultural Land Classification of England and Wales (1:250,000)⁵;
- Likelihood of Best and Most Versatile Agricultural Land (1:250,000)⁶;
- agri-environment schemes⁷;
- computer generated light detection and ranging (LiDAR) elevation data for determination of gradient;
- aerial photography; and
- site-specific soil and ALC surveys.

2.1.3 Information gathered by field survey has related to the enhancement of desk-based information on soils and agricultural land quality and the engagement with landowners and tenants to establish the nature and extent of agricultural, forestry and related rural enterprises.

2.1.4 Where the collection of agricultural site information has enabled a review/refinement of published information this was undertaken in accordance with the methodology prescribed by the Ministry of Agriculture, Fisheries and Food (MAFF)⁸.

¹ Cranfield University, (2001), *The National Soil Map of England and Wales 1:250,000 scale*.

² Soil Survey of England and Wales, (1984), *Soils and Their Use in South East England*.

³ British Geological Survey. <http://bgs.ac.uk/geologyofbritain/home/html>: Accessed on 18 March 2013

⁴ Meteorological Office (1989), *Gridpoint Meteorological data for Agricultural Land Classification of England and Wales and other Climatological Investigations*.

⁵ Ministry of Agriculture, Fisheries and Food, (MAFF) (1983), *Agricultural Land Classification of England and Wales (1:250,000)*.

⁶ Department for Environment, Food and Rural Affairs, (Defra) (2005), *Likelihood of Best and Most Versatile Agricultural Land (1:250,000)*.

⁷ Multi-Agency Geographical Information for the Countryside (MAGIC) available on line @ <http://www.magic.gov.uk/>: Accessed August 2013.

⁸ MAFF, (1988), *Agricultural Land Classification of England and Wales – Revised guidelines and criteria for grading the quality of agricultural land*.

2.1.5 Engagement with landowners and tenants between May 2012 and June 2013 has established the nature and extent of agricultural, forestry and related rural enterprises. Information obtained from farm impact assessment interview surveys has been taken as a factual representation of local agricultural and forestry interests and has not been subject to further evaluation.

2.2 Soils and land resources

2.2.1 This part of the appendix describes the findings of a desktop study and targeted soil survey and ALC survey that identified existing soil and agricultural land resources in the study area.

2.2.2 The only agricultural land subject to a soil survey was at Grove Farm (Holding CFA10/10) with the survey carried out in September 2012. The site was chosen as it was considered that the results would be representative of the surrounding agricultural land. Permission was sought to access a wider area for survey but was not granted.

2.2.3 The location and extent of different soil types and agricultural land in the different ALC grades are influenced by topography and drainage and by geology and soil parent materials which are described in turn in the following section.

Topography and drainage

2.2.4 The southern end of the study area is characterised by a series of hills and valleys of the Chilterns Area of Outstanding Natural Beauty (AONB) with the dry valley of Wendover Dean being the dominant landform. From the valley bottom at approximately 150m above Ordnance Datum (AOD) steep chalk slopes rise to 225m AOD orientated broadly north-east to south-west. The settlement of Wendover lies to the north-east of the study area where the valley bottom, the broad Aylesbury Vale and the north-western scarp face of the Chilterns escarpment meet. The only surface water feature of note is the Grand Union Canal (Wendover Arm) with small tributaries of the River Thame also found to the north of the area.

Geology and soil parent materials

2.2.5 The principal underlying geology mapped by the British Geological Survey is that of the White Chalk subgroup which outcrops to form a long north-east to south-west escarpment facing north-west. There is a long backslope which gradually falls to the south-east and which is covered by various plateau drift deposits. The Chalk is principally hard chalk with occasional interbedded soft to medium hard chalcs, flints and marls (lime-rich mudstone).

2.2.6 The principal underlying geology is that of the Chalk Group including the Lewes Nodular Chalk Formation in the south-east of the section, Holywell Nodular Chalk in the mid-section and the West Melbury Marly Chalk Formation to the north near Wendover. Superficial clay, silt, sand and gravel deposits of the Clay-with-Flints Formation are mapped overlying the Lewes Nodular Chalk Formation.

2.2.7 At the very northern end of the section undifferentiated bedrock of the Gault and Upper Greensand Formations are mapped. The Gault Formation bedrock comprises

clay or mudstone while the Upper Greensand Formation comprises sand and sandstones with some silt. Even further to the north-west is found an extensive clay plain formed on the Kimmeridge Clay.

2.2.8 A list of geological strata occurring within the study area is provided in age order in Table 1 and shown on Map WR-02-10 (Volume 5, Water resources and flood risk).

Table 1: Bedrock and soil forming materials

Formation	Composition/soil parent material
Kimmeridge Clay	Calcareous kerogen-rich silty or sandy mudstones with thin siltstone and cementstone beds
Gault	Clay or mudstone, with a sandy base
Upper Greensand	Sand and sandstone, fine-grained, silt, shelly
West Melbury Marly Chalk	Soft marly chalk and hard grey limestone arranged in couplets
Lewes Nodular Chalk	Hard to very hard nodular chalk with interbedded soft to medium chalks
Holywell Nodular Chalk	Hard nodular chalk with shell debris
Superficial deposits	
Clay-With-Flints	Unbedded, heterogeneous sandy clay with pebbles of flint, formed from bedrock of the Chalk Group, Palaeogene formations and the Upper Greensand Formation

Description and distribution of soil types

2.2.9 The characteristics of the soils are described by the Soil Survey of England and Wales² and shown on the National Soil Map¹. The soils are grouped into associations of a range of soil types and their distribution is shown on Map AG-02-010 (Volume 5, Agriculture, Forestry and Soils Map Book).

2.2.10 The National Soil Map shows seven soil associations. The dry valley is occupied by the well-drained (Wetness Class⁹ (WC) - WC I), silty loam Charity 2 association which develops in flinty chalky drift over Chalk bedrock. Upslope from the Charity 2 soils are those of the Batcombe association (WC II), developed in Clay-with-Flints and plateau drift, which caps chalk and comprises silty loam topsoils over clayey subsoils.

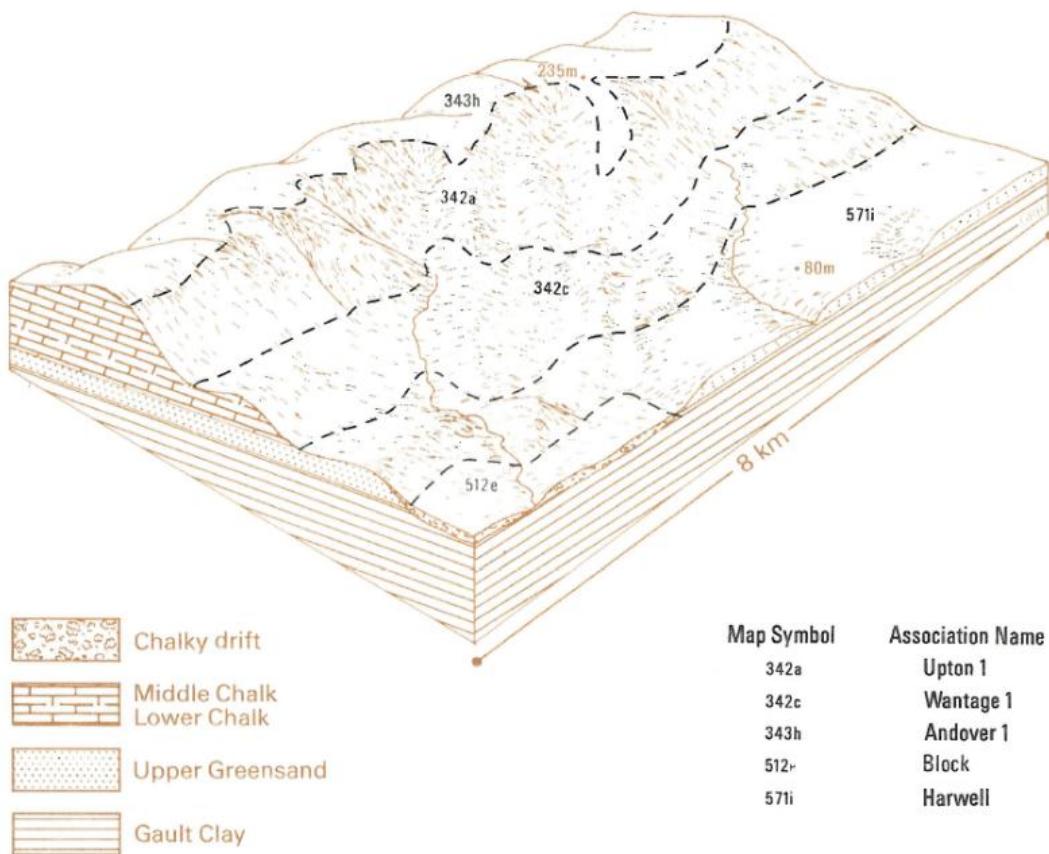
2.2.11 In the north-west, bands of Andover 1, Wantage 1, Upton 1, Block and Bignor soils are aligned roughly north-east to south-west and generally reflect the geology and sloping topography. Andover 1 soils comprise well to excessively well drained (WC I) variably flinty and chalky silty loam soils overlying chalk, found on undulating chalkland. Wantage 1 soils are also well drained (WC I), and comprise silty clay loam topsoils over similar subsoil and which occur on moderately sloping chalk. Soils of the Upton 1 association occur mainly on steep slopes and escarpments and comprise shallow, well drained to excessively well drained (WC I), silty loam topsoils over chalk or chalk rubble. All are slightly to moderately droughty for common agricultural crops.

⁹ The Wetness Class (WC) of a soil is classified according to the depth and duration of waterlogging in the soil profile and has six bands.

2.2.12 The Block association, developed in chalky and gravelly drift, is characterised by calcareous profiles which are of clay loam or sandy clay loam texture throughout and are moderately well drained (WC II). As the geology changes from chalk to Gault and Upper Greensand Formations, soils of the Bignor association are present and comprise sandy silt loam topsoils with clay loam subsoils over sandstone. They are affected by periodic and localised waterlogging and the soils are commonly of WC II or III.

2.2.13 Figure 1 depicts the typical locations in which examples of the above soil associations are found. The soils are mapped in the context of topography and underlying geology.

Figure 1: Upton 1 (342a), Wantage 1 (342c), Andover 1 (343h) and Block (512e) associations in a landscape context¹⁰



2.2.14 Where profile descriptions are available, the dominant soil series of each association is described in detail in Table 2. References to soil colours have been derived from a standard Munsell Soil Colour Chart¹¹.

Table 2: Dominant soil series

Wantage series	Bignor series	Block series
ocm-28cm, greyish brown (2.5Y5/2) ¹² very slightly stony silty clay loam; angular black flint; strongly developed fine to coarse subangular blocky; medium packing density; moderately firm soil strength; common fine roots; very calcareous; abrupt boundary	ocm-20cm, dark greyish brown (10YR4/2) stoneless sandy silt loam with few very fine dark yellowish brown (10YR4/6) mottles; moist; weakly developed fine subangular blocky; medium packing density; moderately weak soil and ped strength; common very fine fibrous roots; non-calcareous; common organic coats; sharp smooth boundary	ocm-25cm, dark brown (7.5YR3/2) very slightly stony sandy clay loam; small subangular flint and chalk; slightly moist; weakly developed very coarse subangular blocky; high packing density; moderately firm soil and ped strength; common very fine fibrous roots; slightly calcareous; sharp smooth boundary

¹⁰ National Soil Resources Institute 2013. *The Soils Guide*. Available: <http://www.landis.org.uk>. Cranfield University, UK.

¹¹ Munsell Color (2000), *Munsell Color Charts*, Munsell Color, Grand Rapids, MI, USA.

¹² Munsell colour notation describes colour by three attributes: hue (with five principal colours - red (R), yellow (Y), green (G), blue (B), and purple (P) with a preceding intermediate value 2.5-10; value or brightness where zero is black (most dark) and ten is white (most light); and chroma that distinguishes the difference from a pure hue to a gray shade.

Wantage series	Bignor series	Block series
28cm-36cm, light brownish grey (2.5Y6/2) very slightly stony silty clay loam; small, soft chalk; moderately developed coarse blocky breaking to strongly developed fine blocky; moderately firm soil strength; few fine roots; extremely calcareous; clear boundary	20cm-35cm, brown to dark brown (10YR4/3) very slightly stony sandy loam; medium angular and platy, glauconitic sandstone; moist; weakly developed medium angular blocky with dark greyish brown (10YR4/2) faces; medium packing density; moderately weak soil and ped strength; few very fine fibrous roots; non-calcareous; abrupt wavy boundary	25cm-46cm, dark yellowish brown (10YR4/4) very slightly stony sandy clay loam; small and medium flint and chalk; slightly moist; weakly developed very coarse subangular blocky; medium packing density; moderately firm soil and ped strength; few very fine fibrous roots; slightly calcareous; clear smooth boundary
36cm-60cm, light grey (2.5Y7/2) very stony silty clay loam; angular soft chalk; moderately weak soil strength; few roots; extremely calcareous; smooth boundary	35cm-43cm, brown to dark brown (10YR4/3) very slightly stony sandy loam; medium angular and platy glauconitic sandstone; moist; moderately developed medium angular blocky with dark greyish brown (10YR4/2) faces; medium packing density; moderately weak soil and ped strength; few very fine fibrous roots; non-calcareous; abrupt wavy boundary	46cm-55cm, yellowish brown (10YR5/4) very slightly stony sandy clay loam with common fine yellowish brown (10YR5/6) mottles; small subangular flint and chalk; slightly moist; weakly developed coarse subangular blocky; medium packing density; moderately weak soil and ped strength; few very fine fibrous roots; calcareous; clear smooth boundary
60cm-90cm, bedded tabular fragments and layers of soft grey chalk with infillings of lower subsoil material	43cm-75cm, light brownish grey (2.5Y6/2) slightly stony clay loam with very many medium strong brown (7.5YR5/6) mottles; large angular and platy glauconitic sandstone; very moist; weakly developed coarse angular blocky with greyish brown (2.5Y5/2) faces; medium packing density; moderately firm soil and strength; non-calcareous; few clay coats; clear wavy boundary	55cm-70cm, yellowish brown (10YR5/4) slightly stony sandy loam with common yellowish brown (10YR5/8) mottles; small subangular flint and chalk; slightly moist; moderately developed fine subangular blocky; low packing density; moderately weak soil and ped strength; few very fine fibrous roots; very calcareous; common, irregular soft calcareous concentrations; clear smooth boundary
	75cm-100cm, light brownish grey (10YR6/2) very large tabular fine sandstone with many large (10YR5/6) mottles and streaks; greyish clay concentrations at stone contacts	70cm-84cm, greyish brown (2.5Y5/2) and yellowish brown (10YR5/4) moderately stony sandy loam with common medium yellowish brown (10YR5/8) and light olive brown (2.5Y5/3) mottles; small subangular flint and chalk; slightly moist; low packing density; very weak soil and ped strength; very few fine fibrous roots; very calcareous; common irregular soft calcareous concentrations; sharp wavy boundary

Wantage series	Bignor series	Block series
		84cm-100cm, grey (5Y5/1) stoneless clay with common fine light olive brown (2.5Y5/4) and olive brown (2.5Y4/4) mottles; slightly moist; moderately developed coarse subangular blocky; high packing density; moderately strong soil and ped strength; few very fine fibrous roots; very calcareous; common rounded soft calcareous concentrations

2.3 Soil and land use interactions

Agricultural land quality

2.3.1 A review of background ALC information has been undertaken to ascertain the land quality within the study area. The review also sought to identify the extent of existing detailed post-1988 ALC information to ensure that surveys are not repeated unnecessarily.

2.3.2 Within the study area there is very little existing detailed post-1988 ALC data. To better inform the ALC in this area a soil survey was conducted at Grove Farm, Wendover. Access to other holdings was requested but was not granted. In areas where permission was not granted land quality has been assessed from available information.

Detailed Agricultural Land Classification survey - Grove Farm

2.3.3 At the time of the survey the land at Grove Farm was being grazed by horses and cattle.

2.3.4 Soil profiles were examined using an Edelman (Dutch) auger and spade. Approximately one observation was made for each 100m linear run of the Proposed Scheme. At each observation point the following characteristics were assessed for each soil horizon up to a maximum of 120cm or any impenetrable layer:

- soil texture;
- significant stoniness;
- colour (including local gley and mottle colours);
- consistency;
- structural condition;
- free carbonate; and
- depth.

2.3.5 Soil WC was inferred from the matrix colour, presence or absence of, and depth to, greyish and ochreous gley mottling and/or poorly permeable subsoil layers at least 15cm thick.

2.3.6 Soil droughtiness was investigated by the calculation of moisture balance equations. Crop-adjusted available water is estimated from texture, stoniness and depth and then compared to a calculated moisture deficit for the standard crops wheat and potatoes. The moisture deficit is a function of potential evapotranspiration and rainfall. Grading of the land can be affected if the available water is insufficient to balance the deficit and droughtiness occurs. When a profile is found with significant stoniness, sufficient to prevent penetration of a hand auger, then it is assumed for the purposes of calculating droughtiness that similar levels of stoniness continues to the full 1.2m depth considered. The methodology and calculation used to determine the severity of a droughtiness limitation is given in Figure 2.

Figure 2: Methodology for calculating Agricultural Land Classification grade according to soil droughtiness¹³

$$AP \text{ wheat (mm)} = \frac{TA_{vt} \times LT_t + \sum (TA_{vs} \times LT_{50}) + \sum (EA_{vs} \times LT_{50-120})}{10}$$

where

TA_{vt} is Total available water (TA_v) for the topsoil texture

TA_{vs} is Total available water (TA_v) for each subsoil layer

EA_{vs} is Easily available water (EA_v) for each subsoil layer

LT_t is thickness (cm) of topsoil layer

LT_{50} is thickness (cm) of each subsoil layer to 50 cm depth

LT_{50-120} is thickness (cm) of each subsoil layer between 50 and 120 cm depth

Σ means 'sum of'.

$$AP \text{ potatoes (mm)} = \frac{TA_{vt} \times LT_t + \sum (TA_{vs} \times LT_{70})}{10}$$

where

LT_{70} is thickness (cm) of each subsoil layer to 70 cm depth

MB (Wheat) = **AP (Wheat)** - **MD (Wheat)**

MB (Potatoes) = **AP (Potatoes)** - **MD (Potatoes)**

Where

MB is the Moisture Balance

AP is the Crop-adjusted available water capacity

MD is the moisture deficit, as determined by the agro-climatic assessment.

Table 8 Grade according to droughtiness

Grade/ Subgrade	Moisture Balance limits (mm)		
	wheat	and	potatoes
1	+30	and	+10
2	+5	and	-10
3a	-20	and	-30
3b	-50	and	-55
4	<-50	or	<-55

¹³ From: MAFF (1988), *Agricultural Land Classification of England and Wales – Revised guidelines and criteria for grading the quality of agricultural land*.

2.3.7 Agro-climatic data at Grove Farm (Table 3) show the site to have moderate rainfall and cool temperatures. Moisture deficits are moderate. The number of field capacity days (FCD) at Grove Farm is slightly larger than the average for lowland England and is therefore considered to be slightly unfavourable for agricultural land works.

Table 3: Agro-climatic conditions at Grove Farm

Climatic parameter	Grove Farm
OS Grid Reference	SP 805 115
Altitude (m AOD)	145m
Average annual rainfall	725mm
Accumulated temperature above 0°C	1,345 day°
Field capacity days	162 days
Average moisture deficit, wheat	99mm
Average moisture deficit, potatoes	87mm

2.3.8 The topsoils found at Grove Farm are described in Table 4 and correlate well with those described as present by the Soil Survey of England and Wales though variation is seen in soil depth. Profiles described in full extend to an average of around 95cm whilst profiles found were extremely shallow reaching an average of just 20cm before stones obstructed further observations.

2.3.9 All profiles were consequently assessed as being of WC I but restricted to Subgrade 3b by a droughtiness limitation. Although no subsoils could be recorded this is not to say that they are absent; it is possible that soils that are impenetrable by auger could be easily reached by plant roots however this could not be assumed in this assessment.

Table 4: Soil profile description from Grove Farm

Grove Farm
0-20cm, very dark greyish brown (10YR3/2) silty clay loam; 10% chalk stones; very calcareous; moderately sloping land; shallow

Desk assessment of Agricultural Land Classification

2.3.10 The Dunsmore, Wendover and Halton section has been subject to a detailed desk-based assessment and interpretation of soil mapping, topography and agro-climatic data and their interactions. This resulted in an assessment of the likely soil textures, soil drainage status, landform, gradient, presence of or depth to poorly permeable soil layers and the extent to which crop growth may be limited by soil droughtiness.

2.3.11 A professional judgement was then made as to the predominant ALC grade which is likely for a soil with given characteristics in the climatic zone specific to CFA10. The judgement is influenced by the surveyor's experience of detailed surveys in the locality and on similar soil types. The resulting grade is that which is considered to be the most likely grade that would be found should a detailed site investigation be conducted, although this does not mean in all cases that that grade will be found in practice.

2.3.12 Context land quality was ascertained using information derived from the provisional ALC maps of England and Wales produced by MAFF in the 1960s and 1970s. These maps show the section to be provisionally mapped as Grade 3 with some Grade 2 to the north. These maps were originally published at a scale of 1:63,360 and are available at a scale of 1:250,000 in paper and digital formats. These maps were published at strategic scales only and based on a methodology that has since been revised twice and cannot be used definitively to classify individual sites and analysis of other information sources is necessary.

Agro-climatic limitations

2.3.13 The local agro-climatic data have been interpolated from the Meteorological Office's standard 5km grid point data set for two representative points which are set out in Table 5. The data show average rainfall and temperatures to be moderate to moderately high with averages of around 710mm rainfall and 1,360 day°C. The resulting FCD regime is slightly greater than average for lowland England at 159 days and is slightly unfavourable for providing opportunities for land working.

Table 5: Interpolated agro-climatic data

Agro-climatic parameter	Kingsash	Halton
Altitude (AOD)	125m	230m
Average annual rainfall	746mm	669mm
Accumulated temperature above 0°C	1,334 day°	1,384 day°
Field capacity days	166 days	148 days
Average moisture deficit, wheat	96mm	106mm
Average moisture deficit, potatoes	84mm	98mm

Site limitations

2.3.14 The assessment of site factors is primarily concerned with the way in which topography influences the use of agricultural machinery and hence the cropping potential of land. Gradient and microrelief with complex changes of slope angle or direction over short distances is considered likely to be a limiting factor across a large proportion of the agricultural land within this section.

Soil limitations

2.3.15 The main soil properties which affect the cropping potential and management requirements of land are texture, structure, depth, stoniness and chemical fertility. Together they influence the functions of soil and affect the water availability for crops, drainage, workability and trafficability. There are two distinct soil characteristics within the study area which are the fine loamy or silty textures of soils on plateaux overlying Clay-with-Flints and those of the remainder of the section which are well drained and silty overlying Chalk. It is likely that on some of the slopes in the section soil depth may be a limiting factor on the ALC grading.

Interactive limitations

2.3.16 The physical limitations which result from interactions between climate, site and soil are soil wetness, droughtiness and susceptibility to erosion. Each soil can be allocated a WC based on soil structure, evidence of waterlogging and the number of FCD. The topsoil texture then determines the ALC according to Table 6 of the MAFF ALC guidelines shown in Figure 3.

Figure 3: Agricultural land classification grade according to soil wetness¹⁴

Wetness Class	Texture ¹ of the top 25 cm	Field Capacity Days			
		<126	126-150	151-175	176-225
I	S ² LS ³ SL SZL	1	1	1	1
	ZL MZCL MCL SCL	1	1	1	2
	HZCL HCL	2	2	2	3a
	SC ZC C	3a(2)	3a(2)	3a	3b
II	S ² LS ³ SL SZL	1	1	1	2
	ZL MZCL MCL SCL	2	2	2	3a
	HZCL HCL	3a(2)	3a(2)	3a	3a
	SC ZC C	3a(2)	3b(3a)	3b	3b
III	S ² LS SL SZL	2	2	2	3a
	ZL MZCL MCL SCL	3a(2)	3a(2)	3a	3a
	HZCL HCL	3b(3a)	3b(3a)	3b	3b
	SC ZC C	3b(3a)	3b(3a)	3b	4
IV	S ² LS SL SZL	3a	3a	3a	3b
	ZL MZCL MCL SCL	3b	3b	3b	3b
	HZCL HCL	3b	3b	3b	4
	SC ZC C	3b	3b	3b	5
V	S LS SL SZL	4	4	4	4
	ZL MZCL MCL SCL	4	4	4	4
	HZCL HCL	4	4	4	4
	SC ZC C	4	4	4	5

Soils in Wetness Class VI - Grade 5

¹For naturally calcareous soils with more than 1% CaCO₃ and between 18% and 50% clay in the top 25 cm, the grade, where different from that of other soils, is shown in brackets

² Sand is not eligible for Grades 1, 2 or 3a

³ Loamy sand is not eligible for Grade 1

Where S = sand, Z = silt, C = clay, L = loamy and P= peat.

For sand the coarseness of the grain is sub-divided into coarse (c), medium (m) and fine (f). The subdivisions of clay loam and silty clay loam classes are indicated as medium (M) (less than 27% clay); heavy (H) (27-35% clay).

The average number of FCD in the Dunsmore, Wendover and Halton area is 159, and is shown in the highlighted column.

¹⁴ From: MAFF (1988), Agricultural Land Classification of England and Wales – Revised guidelines and criteria for grading the quality of agricultural land.

2.3.17 The Charity 2, Andover 1, Upton 1 and Wantage 1 associations are all well draining, very slightly stony to moderately stony silty clay loam soils. Under the climatic conditions within the route section, with an average FCD regime of 159 days, soil wetness will have a limitation to the grading of these soils to Grade 2 or 3a. The soils are also slightly to moderately droughty which further limits the grading to Grade 2 or 3a.

2.3.18 The Batcombe association which has slightly stony silt loam or silty clay loam over slightly stony clay soils is typically of WC II or III and can be limited by wetness to any Grade between 2 and 3b. This is locally dependent on the relative proportions of sand, silt and clay components in the topsoil. For example, where assessed as WC II, a medium clay loam topsoil will result in land being of Grade 2 quality while a silty clay topsoil will result in Subgrade 3b quality land. Soils of WC III are a little less variable with silt loam, medium silty clay loam and medium clay loam topsoils all resulting in Subgrade 3a and the remaining fine silty and loamy textures resulting in Subgrade 3b.

2.3.19 The Block association soils of WC II and with sandy clay loam or clay loam topsoil textures are limited to Grade 2 or Subgrade 3a by soil workability. These soils may be slightly droughty for grass and hence would be expected to be also limited to Subgrade 3a by droughtiness. Soils of the Bignor association with sandy silt loam topsoil and WC II will have a workability limitation to Subgrade 3a and are also slightly droughty.

3 Forestry

3.1.1 Data on the forestry resources in the study area has primarily been derived from the National Forest Inventory¹⁵. The area of land under forestry (i.e. trees and woodland) within 2km either side of the route centre line has been derived using a Geographic Information System (GIS), and is shown in Table 6.

3.1.2 The study area contains a large area of woodland though the majority is located away from the route of the proposed scheme. The only significant area of woodland close to the proposed scheme is Jones' Hill Wood to the south of the study area.

Table 6: Area of woodland within the study area and construction boundary

	Area of forestry land (ha)	Percentage of forestry land (%)
Forestry land in study area	571.5	18% (woodland land use within 4km-wide study area)
Total forestry land within construction boundary	2.1	Less than 1% of the land required for the construction of the Proposed Scheme is presently woodland

¹⁵ Forestry Commission (2001), *National Forest Inventory Woodland and Ancient Woodland* (as updated).

4

Assessment of effects on holdings

4.1.1 The effects on holdings have been assessed through a series of interviews with farmers along the proposed route carried out between May 2012 and June 2013, as well as measurements of the applicable area of land required, according to the methodology set out in the Scope and Methodology Report (SMR) (Volume 5: Appendix CT-001-000/1) and the SMR Addendum (Volume 5, Appendix CT-001-000/2).

4.1.2 The nature of impacts considered comprises the temporary and permanent land required from the holding, the temporary and permanent severance of land, the permanent loss of key farm infrastructure and the imposition of disruptive effects (particularly noise and dust) on land uses and the holding's operations. These impacts occur primarily during the construction phase of the Proposed Scheme and are set out in Table 7.

Table 7: Summary of assessment of effect on holdings

Holding reference, name and description	Construction effects	Residual effects post restoration of land required temporarily
CFA10/1 Hunt's Green Farm 100ha arable, beef cattle and sheep Medium sensitivity to change	Land required: 47.8ha (48%). High impact Severance: land severed but accommodation bridge provided. During sustainable on-site placement of excavated materials use of public highway will be required. Medium impact Disruptive effects: no impact on agricultural activity: construction dust and noise controlled via the mitigation measures set out within the draft Code of Construction Practice ¹⁶ (CoCP). Negligible impact	Land required: 14.3ha (14%). Medium impact Severance: land severed but accommodation bridge provided or accessed via public highway. Low impact Infrastructure: no demolition and no other farm infrastructure affected. Negligible impact
	Overall temporary assessment: major/moderate effect due to proportion of farm required, in part for provision of sustainable on-site placement area	Overall permanent assessment: moderate effect due to percentage of farm required
CFA10/2 Strawberryhill Farm 220ha arable, beef cattle and sheep Medium sensitivity to change	Land required: 43ha (20%). High impact Severance: no access provided to land east of Bacombe Lane during construction of cut and cover tunnel. High impact Disruptive effects: no impact on agricultural activity: construction dust and noise controlled via the mitigation measures set out within the draft CoCP. Negligible impact	Land required: 23.5ha (11%). Medium impact Severance: dispersed holding already - all land should be accessible from public highway (as presently). Negligible impact Infrastructure: no demolition and no other farm infrastructure affected. Negligible impact
	Overall temporary assessment: major/moderate effect due to proportion	Overall permanent assessment: moderate effect due to percentage of farm lost

¹⁶ Volume 5: Appendix CT-003-000

Holding reference, name and description	Construction effects	Residual effects post restoration of land required temporarily
	of farm required and severance	
CFA10/3*	<p>Land required: 15.9ha (25%). High impact</p> <p>Severance: severed land to the north of the viaduct accessible via realigned farm track. Low impact</p> <p>Disruptive effects: no impact on agricultural activity: construction dust and noise controlled via the mitigation measures set out within the draft CoCP. Negligible impact</p>	<p>Land required: 6.5ha (10%). Medium impact</p> <p>Severance: access to land under Wendover Dean viaduct. Negligible impact</p> <p>Infrastructure: farmstead demolished. High impact</p>
Durham Farm 63ha arable and beef cattle Medium sensitivity to change	Overall temporary assessment: major/moderate effect due to proportion of the holding required	Overall permanent assessment: major/moderate effect due to proportion of the holding required and farmstead demolition
CFA10/5	<p>Land required: 23.1ha (46%). High impact</p> <p>Severance: small area of severed land to the north of the viaduct inaccessible during construction phase downgraded due to small area. Medium impact</p> <p>Disruptive effects: no impact on agricultural activity: construction dust and noise controlled via the mitigation measures set out within the draft CoCP. Negligible impact</p>	<p>Land required: 6.2ha (12%). Medium impact</p> <p>Severance: access to land under Wendover Dean viaduct and realigned farm track. Low impact</p> <p>Infrastructure: no demolition and no other farm infrastructure affected. Negligible impact</p>
Upper Wendover Dean Farm 50ha arable and beef cattle Medium sensitivity to change	Overall temporary assessment: major/moderate effect due to temporary land loss and lack of access to land severed to north of viaduct	Overall permanent assessment: moderate effect due to percentage of farm required
CFA10/6	<p>Land required: 5.7ha (88%). High impact</p> <p>Severance: land to the south of the Proposed Scheme required for construction therefore not severed. Negligible impact</p> <p>Disruptive effects: noise impacts on non-agricultural tenants in let farm buildings. Medium impact</p>	<p>Land required: 3.7ha (56%). High impact</p> <p>Severance: land severed to the south of the Proposed Scheme accessed from Rocky Lane. Medium impact</p> <p>Infrastructure: noise impacts on non-agricultural tenants in let farm buildings. Medium impact</p>
Hartley Farm 6.5ha land (let) Low sensitivity to change	Overall temporary assessment: moderate effect due the proportion of the holding required and nuisance but low sensitivity of holding	Overall permanent assessment: moderate effect due the proportion of the holding required and nuisance
CFA10/7	<p>Land required: 10.3ha (37%). High impact</p> <p>Severance: land severed to the north of the Proposed Scheme no access provided. High impact</p> <p>Disruptive effects: no impact on agricultural activity: construction dust and noise controlled via the mitigation</p>	<p>Land required: 4.3ha (15%). Medium impact</p> <p>Severance: land severed to the north of the Proposed Scheme no access provided. High impact</p> <p>Infrastructure: farmstead demolished.</p>

Holding reference, name and description	Construction effects	Residual effects post restoration of land required temporarily
	measures set out within the draft CoCP. Negligible impact	High impact
	Overall temporary assessment: moderate effect due to the proportion of the holding required, severance and low sensitivity of holding Land required: 11.3ha (12%). Medium impact Severance: no new severance; offlying land will continue to be accessed from public highway. Negligible impact Disruptive effects: no impact on agricultural activity: construction dust and noise controlled via the mitigation measures set out within the draft CoCP. Negligible impact	Overall permanent assessment: moderate effect due to farmstead demolition, the proportion of the holding required, severance, and low sensitivity Land required: 2.0ha (2%). Negligible impact Severance: no new severance; offlying land will continue to be accessed from public highway. Negligible impact Infrastructure: no demolition, and no other farm infrastructure affected. Negligible impact
	Overall temporary assessment: moderate effect due to the proportion of the holding required and medium sensitivity of holding	Overall permanent assessment: negligible effect
	Land required: 31.7ha (16%). Medium impact Severance: 3ha to the south-west of green tunnel will not be accessible during construction - but downgraded due to small area. Medium impact Disruptive effects: no impact on agricultural activity: construction dust and noise controlled via the mitigation measures set out within the draft CoCP. Negligible impact	Land required: 8.3ha (4%). Negligible impact Severance: no new severance - access over green tunnel. Negligible impact Infrastructure: no demolition, and no other farm infrastructure affected. Negligible impact
	Overall temporary assessment: moderate effect due to the proportion of the holding required	Overall permanent assessment: negligible effect
	Land required: 7.9ha (9%). Low impact Severance: 0.5ha severed to east of pylon diversion but impact reduced due to small size. Low impact Disruptive effects: no impact on agricultural activity: construction dust and noise controlled via the mitigation measures set out within the draft CoCP. Negligible impact	Land required: 4.0ha (4%). Negligible impact Severance: none. Negligible impact Infrastructure: no demolition, and no other farm infrastructure affected. Negligible impact
	Overall temporary assessment: minor effect due to proportion of the holding required and severance	Overall permanent assessment: negligible effect

Holding reference, name and description	Construction effects	Residual effects post restoration of land required temporarily
CFA10/11 Smalldean Farm 66ha grassland (let) Low sensitivity to change	Land required: 6ha (9%). Low impact Severance: none. Negligible impact Disruptive effects: no impact on agricultural activity: construction dust and noise controlled via the mitigation measures set out within the draft CoCP. Negligible impact	Land required: 1.1ha (2%). Negligible impact Severance: none. Negligible impact Infrastructure: no demolition, and no other farm infrastructure affected. Negligible impact
	Overall temporary assessment: negligible effect	Overall permanent assessment: negligible effect
CFA10/12 Wellwick Farm 81ha arable and equine Medium sensitivity to change	Land required: 25.6ha (32%). High impact Severance: none. Negligible impact Disruptive effects: no impact on agricultural activity: construction dust and noise controlled via the mitigation measures set out within the draft CoCP. Negligible impact	Land required: 11.6ha (14%). Medium impact Severance: 0.4ha severed to the east of the Proposed Scheme and inaccessible. High impact reduced to low due to small size of land parcel Infrastructure: no demolition, and no other farm infrastructure affected. Negligible impact
	Overall temporary assessment: major/moderate effect due to the proportion of the holding required	Overall permanent assessment: moderate effect due to the proportion of the holding required
CFA10/13 Orchard Farm 21.9ha derelict orchard and grazing Low sensitivity to change	Land required: 0.9ha (4%). Negligible impact Severance: none. Negligible impact Disruptive effects: no impact on agricultural activity: construction dust and noise controlled via the mitigation measures set out within the draft CoCP. Negligible impact	Land required: 0.7ha (3%). Negligible impact Severance: none. Negligible impact Infrastructure: no demolition, and no other farm infrastructure affected. Negligible impact
	Overall temporary assessment: negligible effect	Overall permanent assessment: negligible effect
CFA10/14 Nash Lee Farm 89ha beef cattle, sheep and arable Medium sensitivity to change	Land required: 5.5ha (6%). Low impact Severance: none. Negligible impact Disruptive effects: no impact on agricultural activity: construction dust and noise controlled via the mitigation measures set out within the draft CoCP. Negligible impact	Land required: 4.7ha (5%). Low impact Severance: none. Negligible impact. Infrastructure: no demolition, and no other farm infrastructure affected. Negligible impact
	Overall temporary assessment: minor effect	Overall permanent assessment: minor effect
CFA10/15 * Un-named paddock 5ha grazing	Land required: 3.3ha (67%). High impact Severance: none. Negligible impact Disruptive effects: no impact on agricultural activity: construction dust and	Land required: 1.8ha (37%). High impact Severance: two small parcels severed (total 1.5ha) and no access available. High impact

Holding reference, name and description	Construction effects	Residual effects post restoration of land required temporarily
	noise controlled via the mitigation measures set out within the draft CoCP. Negligible impact	Infrastructure: no demolition, and no other farm infrastructure affected. Negligible impact
Low sensitivity to change	Overall temporary assessment: moderate effect due to proportion of the holding required	Overall permanent assessment: moderate effect due to proportion of the holding removed
CFA10/16 *	<p>Land required: 3.7ha (8%). Low impact</p> <p>Severance: although the land is partially severed during utility works diversion there should be full access to other land as specified in the draft CoCP. Negligible impact</p> <p>Disruptive effects: no impact on agricultural activity: construction dust and noise controlled via the mitigation measures set out within the draft CoCP. Negligible impact</p>	<p>Land required: 0.1ha (< 1%). Negligible impact</p> <p>Severance: none. Negligible impact</p> <p>Infrastructure: no demolition, and no other farm infrastructure affected. Negligible impact</p>
Stocken Farm 48ha arable Medium sensitivity to change	Overall temporary assessment: minor effect due to the proportion of the holding required	Overall permanent assessment: negligible effect
CFA10/17 *	<p>Land required: 12.7ha (80%). High impact</p> <p>Severance: 6.2ha (all the remnant of the holding) severed in various parcels with no access provided. High impact</p> <p>Disruptive effects: no impact on agricultural activity: construction dust and noise controlled via the mitigation measures set out within the draft CoCP. Negligible impact</p>	<p>Land required: 11.4ha (71%). High impact</p> <p>Severance: access to severed parcels will be available along permanent access tracks shown on plans. Medium impact</p> <p>Infrastructure: farm building demolition. High impact</p>
Hunters Leaze 16ha grazing Low sensitivity to change	Overall temporary assessment: moderate effect due to proportion of the holding required, severance and low sensitivity of the holding	Overall permanent assessment: moderate effect due to proportion of the holding required, severance, demolition and low sensitivity of the holding
CFA10/18 *	<p>Land required: 2.7ha (100%). High impact</p> <p>Severance: none. Negligible impact</p> <p>Disruptive effects: no impact on agricultural activity: construction dust and noise controlled via the mitigation measures set out within the draft CoCP. Negligible impact</p>	<p>Land required: 1.7ha (68%). High impact</p> <p>Severance: none. Negligible impact</p> <p>Infrastructure: no demolition, and no other farm infrastructure affected. Negligible impact</p>
Chiltern Million 2.7ha grazing Low sensitivity to change	Overall temporary assessment: moderate effect due to proportion of the holding required and low sensitivity	Overall permanent assessment: moderate effect due to proportion of the holding required and low sensitivity

* No farm impact assessment interview conducted; data estimated

5 References

British Geological Survey. <http://bgs.ac.uk/geologyofbritain/home/html>: Accessed on 18 March 2013

Cranfield University, (2001), *The National Soil Map of England and Wales 1:250,000 scale*.

Department for Environment, Food and Rural Affairs, (Defra) (2005), *Likelihood of Best and Most Versatile Agricultural Land* (1:250,000).

Forestry Commission, (2001), *National Forest Inventory Woodland and Ancient Woodland* (as updated).

Meteorological Office, (1989), *Gridpoint Meteorological data for Agricultural Land Classification of England and Wales and other Climatological Investigations*.

Ministry of Agriculture, Fisheries and Food (MAFF) (1983), *Agricultural Land Classification of England and Wales* (1:250,000).

MAFF, (1988), *Agricultural Land Classification of England and Wales – Revised guidelines and criteria for grading the quality of agricultural land*.

Munsell Color Charts, (2000), *Munsell Color*, Grand Rapids, MI, USA.

National Soil Resources Institute (NSRI), (2013), *The Soils Guide*; Available: www.landis.org.uk. Cranfield University, UK. Last accessed 14/08/2013

Soil Survey of England and Wales (1984), *Soils and Their Use in South East England*.